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wide selection of familiar figures, which have served, quite as much as the text which accompanied them, to advance the science of embryology.

Chapter 1 begins with the following interesting statement:

In the seventeenth and eighteenth centuries, the most confused ideas of the nature of the process of animal development still prevailed. Influenced involuntarily by the religious dogmas of their time, the greatest anatomists and physiologists, with few exceptions, were of the opinion that the germ was merely a much reduced miniature of the later fully developed condition.

Was not the idea of preformation a direct result of observation and reflection upon natural phenomena, quite apart from "religious dogmas"? This indeed appears to be true, and the comment of a distinguished theologian upon Professor Hertwig's statement is as follows:

Let the men of science assume the parentage of their own *homunculi*! I certainly know of no dogma that the germ was a miniature of the man that was to be, nor even a doctrine which could be understood or misunderstood in that sense.

Thus it appears that this introduction needs explanation or revision. The entire work might profitably be expanded at many points, notably so as to include some account of the development of the lymphatic system. But the title of the book disarms such criticism; the *elements* are admirably presented in a text which is simple, direct and substantial throughout.

FREDERIC T. LEWIS

#### SPECIAL ARTICLES

##### ELECTRICAL DENSITY AND ABSORPTION OF $\beta$ -RAYS

THERE have been a number of attempts to relate the absorption coefficients of various bodies for the  $\beta$ -radiation to some physical properties of the absorbing substance. In 1895, Lenard determined the absorption coefficients for cathode rays of a number of bodies, and concluded that the absorption varied approximately as the density, though

his values of  $\mu/D$  differed by more than one hundred per cent. Similar results were obtained for the absorption of  $\beta$ -rays from radium and uranium by Strutt and by Rutherford.

The first to determine the absorption coefficient of a considerable number of elements for the  $\beta$ -rays was Crowther, in 1906.<sup>1</sup> Crowther found the ratio of the absorption coefficient to the density of the elements to increase with the atomic weight of the absorbing element, but apparently not according to any regular law. Crowther, however, plotted the ratio of the absorption coefficient to the density of 31 elements against their respective atomic weights, and obtained a number of points which he divided into groups having no apparent physical or chemical relationships, and showed that the elements in each of these groups could be joined by curves having some resemblance to one another.

It is the purpose of this paper to show that the absorption coefficient of the elements for  $\beta$ -rays is dependent rather upon the electrical density of the absorbing agent than upon its mass density.

It has been shown in a number of papers by the present writer how the electrical charges of the dissociated ions in an electrolytic solution may be calculated from their masses and their migration velocities in an electric field. Knowing these charges and the volume occupied by a gram-atom of an element in its solid state, we may calculate the electric density of the element by dividing its atomic charge by its atomic volume. It is the electric density calculated in this way which seems to be an important determining factor in the absorption of the  $\beta$ -radiation.

Unfortunately, only a small number of atoms have had their charges calculated in this way, but eleven of these are included in the list of thirty-one elements whose absorption coefficients for the  $\beta$ -rays of uranium were determined by Crowther.

In the table below column ii contains the values of  $\lambda/\rho$  for these eleven elements taken

<sup>1</sup> *Phil. Mag.*, 12, p. 379 (1906).

i	ii	iii	iv	v
Element	$\lambda/\rho$	$\lambda$	$D_e$	$\lambda/D_e$
Na.....	4.95	4.8	.66	7.28
Mg.....	5.1	8.9	1.25	7.12
K.....	6.53	5.7	.87	6.55
Ca.....	6.47	10.0	1.28	7.8
Cu.....	6.8	60.6	6.58	9.2
Zn.....	6.95	49.4	5.23	9.45
Sr.....	8.5	21.6	2.04	10.6
Ag.....	8.3	87.2	8.97	9.7
I.....	10.8	53.5	5.17	10.3
Ba.....	8.8	32.8	3.27	10.0
Pb.....	10.8	123.0	11.0	11.2

from Crowther's table, and in column iii are given the corresponding values of  $\lambda$  calculated by multiplying  $\lambda/\rho$  by the densities in the solid form of the corresponding elements. Column iv contains the electrical density,  $D_e$ , calculated by dividing the atomic charges of the elements by their respective atomic volumes in the solid state, and column v contains values  $\lambda/D_e$ . It will be seen that the variations from a mean value are less in column v than in column ii. This is also shown graph-

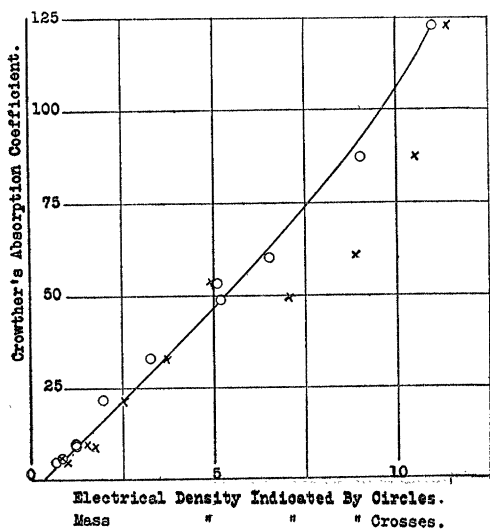


FIG. 1.

ically in Fig. 1, where the mass densities and the electrical densities are plotted against the absorption coefficient. The points representing the relations of the electrical densities to the corresponding absorption coefficients are indicated by circles, while the corresponding points for mass densities are indicated by crosses. It

will be seen that the circles lie more nearly on a smooth curve than do the crosses.

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#### EVIDENCE PROVING THAT THE BELLY RIVER BEDS OF ALBERTA ARE EQUIVALENT WITH THE JUDITH RIVER BEDS OF MONTANA

ON the twenty-fourth of last July a paper of mine appeared in *SCIENCE* in which I took the ground that the Dog Creek Beds of Montana were equivalent to the Edmonton Beds of Alberta and that the Cow Island Beds of Montana should be correlated with the Belly River series of Alberta, with the Fort Pierre deposits between. I thus took the early views of Professor E. D. Cope that the Judith River Beds were on top of the Pierre. Judging from memory, I was unable to believe that the Fort Pierre was on top of the Judith River formation. I concluded, therefore, that the sequence of rocks in Montana would be the same as those in Alberta, where the Belly River series is below the Pierre, and the Edmonton is above.

Last July, however, with Mr. D. B. Dowling, a senior geologist of the Geological Survey of Canada, and my son, Charles M., who took most of the photographs, I spent ten days in the Judith River country, going over the same region I walked over in 1876 as Professor Cope's assistant. I was soon forced by incontestable evidence to change my opinions, and accept without reservations the conclusions of Hatcher and Stanton in their fine work on the "Geology and Paleontology of the Judith River Beds." We actually added to the weight of the evidence they had gathered by the discovery, as I believe for the first time, of some sixty feet of Bear Paw shales on top of the Judith River Beds, on the head of Taffy Creek, an easterly fork of Dog Creek. Also heavy masses on top on the south side of the river near Cow Island. Mr. R. G. McConnell, deputy minister and director of the Geological Survey of Canada, has kindly allowed me to present this paper in a private capacity, Mr. Dowling being the mouthpiece of the Geolog-